



Weaver Bottoms Wildlife Habitat Restoration: A Case Study

PURPOSE: This technical note evaluates the success of a wetland rehabilitation project in the first four years following construction. Backwater areas of the Upper Mississippi River provide important feeding and resting areas for migratory waterfowl, and habitat quality deterioration of these highly productive marshes has been a cause of great concern. The Weaver Bottoms Rehabilitation Project is a large scale wetland restoration project that is directed at regaining lost habitat by creating hydrological and energy conditions conducive to marsh growth and production. Davis et al. (1993) presents the Phase I pre-project (1985-87) and post-construction (1988-91) monitoring results and assesses project impacts on the Weaver Bottoms aquatic system during the first three years following construction. This technical note summarizes that report.

BACKGROUND: In the early 1930's, the U.S. Army Corps of Engineers constructed a series of locks and dams in the Upper Mississippi River to improve commercial navigation along the 848 river miles from Cairo, IL to Minneapolis, MN. Extensive areas of the UMR's floodplain were inundated and rapidly became highly productive backwater marshes. Since the early 1960's, however, aerial coverage and density of wetland vegetation have fluctuated and gradually declined, reducing many backwater marshes to open, windswept, riverine lakes with low fish and wildlife habitat quality.

The Great River Environmental Action Team I was organized in 1973 with representatives from the Army Corps of Engineers, U.S. Fish and Wildlife Service, Wisconsin, and Minnesota to identify and assess the problems associated with multipurpose use of the UMR and to develop recommendations for improved management of its resources. Weaver Bottoms, a 4,000-acre backwater area in Pool 5 of the UMR located between southeastern Minnesota and southwestern Wisconsin, was selected as a representative area for extensive study. It was determined that habitat quality deterioration was due to loss of marsh vegetation. The inability of marsh vegetation to recover was attributed to a variety of reasons, including two major floods in the late 1960's, uprooting and removal of plants by wind and ice, changed flow and sedimentation patterns, and reduced water clarity caused by wind-induced wave resuspension of sediments.

As a result, the Weaver Bottoms Rehabilitation Project was designed to reduce Mississippi River flows entering the backwater by modifying side channels and to reduce wind fetch and re-suspension of bottom sediments by creating barrier islands. Also, the project was to reduce maintenance dredging requirements in the navigation channel and provide long-term dredged material storage. Phase I construction at Weaver Bottoms was completed by mid 1987. Partial or complete closures were constructed across most of the secondary channels leading from the Mississippi River into the area with two 16-acre islands constructed in open waters (Fig. 1). Phase II will be implemented after the effects of Phase I construction have been evaluated.

A comprehensive, 10-year Resource Analysis Plan outlines how to monitor these Phase I project effects. The plan is based on an interagency Memorandum of Understanding, designating the U.S. Fish and Wildlife Service as the lead agency and providing for active participation from the U.S. Army Corps of Engineers, and Wisconsin and Minnesota Departments of Natural Resources.

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MONITORING RESULTS: The Resource Analysis Plan established a 10-year monitoring program to assess project impacts on hydrodynamics, sedimentation, water quality, emergent and aquatic vegetation, use of aquatic and wildlife habitats by birds, fish, and mammals, and recreational use. Results from the first 6 years (1986-1992) of the monitoring program are summarized below.

- **Hydrodynamics.** Monitoring indicated that secondary channel discharges to Weaver Bottoms were reduced 80 percent, and hydraulic residence time was increased 2 to 6 times (from 3 days to 7.6 days in isolated portions) after construction. Current velocities within Weaver Bottoms have been reduced a similar order of magnitude (60-90 percent). The two constructed islands have altered flow patterns; but wave action continues to be a major factor influencing bottom velocities and sediment resuspension. Hydrodynamic impacts of the islands on Weaver Bottoms are small compared to the reduction in inflow due to closure of secondary channels.

There was concern that diversion of flow from Weaver Bottoms would adversely affect adjacent areas of Pool 5. Data indicate that for total river discharges less than 60,000 cfs (greatest flow during the monitoring period), secondary channel discharges, current velocities, and water surface elevations in areas outside of Weaver Bottoms have not been affected.

Overall dredging requirements in the navigation channel near Weaver Bottoms have decreased by 60 percent following project construction. The decrease in dredging requirements during the study period was probably due to greater channel scouring with increased river flows diverted from Weaver Bottoms into the main river channel.

- **Sedimentation.** Bathymetry data were collected pre-project in 1986 and post-project in 1991; 1935 data were also used in the analysis. Construction resulted in notable changes in erosion/deposition patterns in Weaver Bottoms. Although the net change in bathymetry from 1986 to 1991 was small, high rates of both deposition and erosion occurred, indicating that internal factors such as wind generated wave action have increased their influence on the sedimentation patterns in Weaver Bottoms.

General patterns show deposition in deep areas and erosion in shallow areas. Three areas showed the greatest change in bathymetry since project construction. First, the Pritchard Maloney area (Fig. 1), that historically has shown substantial erosion since inundation, has now become a depositional zone, with water depths reduced from a mean of 108 to 90 cm. Second, the delta areas at side channel openings along the main channel side of Weaver showed both deposition and erosion. For instance, from 1986 to 1991 as much as 90 to 120 cm of deposition occurred near remaining inlets to Weaver Bottoms; however, there was erosion of downstream portions of the inlet deltas. The other area that showed a great deal of change was near the mouth of the Whitewater River. In a 1990 Whitewater River study, increased rates of delta expansion were found to be a function of reduced flow velocities into Weaver Bottoms following project construction.

Sedimentation rates from 1935 to 1986 were estimated between 0.18 to 0.22 cm/year, with a net loss in water volume between 12 to 13.8 percent. Limitations with 1991 bathymetric data did not allow for a comparison of post-project sedimentation rates.

- **Water Quality.** A project objective was increased water clarity for improved conditions for vegetation growth, however, neither suspended solids or turbidity levels were reduced. Reduction of inflow from the Mississippi River reduced mixing and flushing rates in Weaver Bottoms. Water quality in downstream portions of the backwater area became more influenced by the Whitewater River, a turbid river which empties directly into Weaver Bottoms (Fig. 1). Variation

(heterogeneity) in water quality values increased among areas within Weaver Bottoms after project construction. Water quality in Weaver Bottoms did not improve within the first 3 years following construction. Completion of the 10-year monitoring program will allow better determination whether this project-induced heterogeneity is long or short term.

- **Vegetation.** Between 1985 and 1990, a general decline in emergent and submergent aquatic vegetation was recorded in the Weaver Bottoms Rehabilitation Project area. Total emergent vegetation biomass decreased from 4069 g/m² in 1985 to 1151 g/m² in 1990. Mean above ground wet weight for submergents decreased from 1404 g/m² in 1985 to 5 g/m² in 1990. The cause of the vegetation loss is unclear but is apparently related to the 1987-89 drought and not due to project construction. Drastic vegetation losses similar to those documented in this study have been noted in Pool 7 and other Upper Mississippi River pools during the same time period.
- **Birds and Mammals.** Aerial waterfowl transect surveys were conducted each fall from 1985 through 1990. Peak waterfowl numbers usually occurred on Pool 5 in late October. Waterfowl use-days increased substantially between 1986 and 1987, but sustained a steady decline during the remaining post-construction period of 1988-90. Annual diving duck (mostly canvasback, *Aythya valisineria*) use-days were more than double that of puddle ducks during the 1985-87 period, but were below or nearly equal to puddle duck use-days 1988-90. This post-construction decline in diving duck use probably reflected the drastic losses of American wildcelery (*Vallisneria spiralis*), a preferred canvasback food, in Weaver Bottoms during 1989 and 1990. Total use-days of tundra swan (*Cygnus columbianus*), another common migratory waterfowl in the area, varied but were lowest in 1989 and 1990 when substantial declines in arrowhead (*Sagittaria* spp.) biomass were detected.

The waterfowl and vegetation declines at Weaver coincide with those observed on Pool 7 where wildcelery acreage plummeted from 3,500 acres in 1987 to less than 300 acres in 1989. Losses in vegetation and waterfowl use on the Weaver Bottoms project area were not attributable to the rehabilitation project, as evidenced by similar losses in nearby Upper Mississippi River pools. Changes in continental populations, habitat conditions, and weather influenced migratory bird use of the river. The occurrence of muskrat (*Ondatra zibethica*), shorebirds, gulls, and terns on Weaver Bottoms was monitored but no population trends were detected.

- **Fish.** Fish populations were monitored within and outside the Weaver Bottoms project area. Trap nets, experimental gill nets, and electroshocking methods were used. Pre-construction sampling yielded 9,323 fish representing 69 species with an average weight of 264 g/fish. Post-construction sampling yielded 16,992 fish, representing 57 species with a higher average weight of 271 g/fish. All sample methods showed an increase in catch per unit effort during the post-construction years. The proportion of sport fish, rough fish, and forage fish captured, showed little change between pre- and post-construction periods.

	By Number		By Weight	
	Pre	Post	Pre	Post
Sport fish	56%	61%	34%	32%
Rough fish	23%	22%	62%	66%
Forage fish	21%	17%	2%	2%

Proportions of fish initially caught during the pre-project and post-construction Weaver Bottoms RAP monitoring program represented by major guilds of the Upper Mississippi River.

Four species were identified as key species in the Weaver Bottoms Resource Analysis Plan: northern pike (*Esox lucius*), carp (*Cyprinus carpio*), bluegill (*Lepomis macrochirus*), and black crappie (*Pomoxis nigromaculatus*). Gill netting data show a biomass increase for all four species in the post-construction period with carp increasing the most. Similar increases in catch per unit effort for the four species at stations within and outside Weaver Bottoms indicate that population increases may be partially due to factors other than the rehabilitation project.

- **Recreation.** Estimates of recreational activity in Pool 5 were made by passive observations at water recreation accesses to Pool 5, boat patrols counting visitors, aerial surveys, and use of recreational lockage figures in 1986, '87 and '89. The Weaver Bottoms project has had little detectable effect on recreational use of Pool 5 thus far. A few new beaches created at closures attract some use.

CONCLUSIONS: Although the findings from the Weaver Bottoms Resource Analysis Program presented in this technical note are preliminary, several important results can be used to improve future efforts to restore river backwater areas. The first outcome of this project indicates the need to identify and treat all causes of habitat degradation to facilitate natural recovery. Wind and current energy in Weaver Bottoms clearly caused physical damage to the plants as well as turbid water, but there were other factors that contributed to the vegetation decline. The plants were unable to recover in Weaver Bottoms after project construction because they were continually weakened by additional stresses such as carp and pesticides in agricultural runoff. In addition, natural developmental phases of a continuously inundated marsh include senescence of the emergent aquatic vegetation that is not able to regenerate by seed and the subsequent development of open water, like what happened in Weaver Bottoms. If all stresses and the natural ecology of the potential restoration site are considered, a combination of treatments may be more effective than concentrating on one factor. In the case of Weaver Bottoms, effective restoration may require active intervention such as water level manipulation to encourage revegetation or planting of desired species. It is likely, however, that carp must be controlled until the vegetation is fully established. Moreover, additional structures may be required, as was outlined for Phase II of the project, to reduce further fetch and wave energy.

In addition to thorough identification and treatment of causes of degradation, the degree of degradation of the site must be considered. Weaver Bottoms had lost most of the emergent vegetation before construction of the rehabilitation project. Regardless of the causes, it is more difficult to restore habitat quality of a severely degraded site than a less degraded site. When natural processes of the functioning ecosystem are lost, it is very difficult to reestablish the complex interrelationships of factors that support those processes. Although it is not advisable to rush into an extensive restoration project without thoroughly investigating the causes of degradation, it is equally inadvisable to begin restoration efforts when the site has lost the capability to recover. Restoration measures will be much less extensive and costly if restoration efforts are applied as early as possible after degradation of the site has been identified and is most easily reversed.

REFERENCE: Davis, Mary M., Nelson, Eric, Burns, Carol, editors. 1993. The Weaver Bottoms Rehabilitation Project Resource Analysis Program: Interim Report (1985-1991). U.S. Fish and Wildlife Service, Winona, MN.

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